ENERGY-EFFICIENT DUAL-SINK ALGORITHMS FOR SINK MOBILITY IN EVENT-DRIVEN WIRELESS SENSOR NETWORKS

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To my wife, Maryam,
For her support, patience, and love

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ABSTRACT

Improving energy-efficiency especially in routing mechanisms is one of the main goals in wireless sensor networks (WSNs). One of the issues of multi-hop routing is the phenomenon of fast energy depletion around the sink known as “sink neighborhood problem”. Recently, employing a dual-sink algorithm has become a popular trend to solve this problem. However, sink selection problem, optimizing the next destination for mobile sink, and finding the optimum next-hop in routing scheme are three other issues that need to be addressed properly in dual-sink approaches. This research firstly presents an energy-efficient dual-sink algorithm with role switching mechanism (EEDARS) to address the sink selection problem in scenarios with non simultaneous events. To this end, a role switching mechanism is applied to the dual-sink algorithm for sending the nearest sink to the event area, hence shorten the path. Secondly, an energy-efficient dual-sink algorithm with fuzzy-based sink mobility (EDAFSM) is developed in which the mobile sink adaptively relocates to an optimum location among multiple events using fuzzy logic. Finally, a fuzzy logic scheme for routing optimization is proposed to improve further energy-efficiency in EEDARS and EDAFSM. The aforementioned proposed algorithms are known as joint dual-sink and fuzzy-based geographic routing in single-event (JDFGR-S) and multi-event (JDFGR-M) WSNs. These algorithms are compared to seven recent and established techniques. Extensive simulation of these algorithms with different conditions through NS2 framework showed significant improvements on the network metrics especially lifetime, residual energy, number of nodes alive, delivery ratio and load distribution without negative effect on the end-to-end delay. The lifetime of JDFGR-S is 10% higher than EEDARS and the lifetime of JDFGR-M is 22% more than EDAFSM. The validation of simulation results show 96.53% and 98.98% reliability for lifetime and energy consumption metrics, respectively. As a conclusion, the proposed algorithms have improved the energy-efficiency in event-driven based WSNs.

ABSTRAK

Meningkatkan kecekapan tenaga terutamanya dalam mekanisme penghalaan adalah salah satu matlamat utama dalam rangkaian sensor tanpa wayar (WSNs). Salah satu isu berkaitan penghantaran menerusi banyak lompatan ialah fenomena kehabisan tenaga yang cepat di sekitar pengumpul yang dikenali sebagai masalah perjiranan pengumpul. Baru-baru ini, penggunaan dwi-pengumpul adalah kaedah popular untuk menangani masalah ini. Walau bagaimanapun, mengoptimumkan destinasi seterusnya untuk pengumpul mudah alih, masalah pemilihan pengumpul, dan mencari lompatan optimum dalam penghalaan adalah tiga isu yang perlu ditangani dengan betul dalam pendekatan dwi-pengumpul. Kajian ini pertamanya membentangkan algoritma dwi-pengumpul cekap tenaga dengan mekanisme pensuisan peranan (EEDARS) dalam usaha untuk menangani masalah pemilihan pengumpul dalam senario dengan peristiwa-peristiwa yang tidak serentak. Untuk tujuan ini mekanisme pensuisan peranan digunakan terhadap algoritma penghantaran pengumpul terdekat ke kawasan peristiwa terkini, dan seterusnya memendekkan laluan. Keduanya, algoritma dwi-pengumpul cekap tenaga dengan pengumpul mudah alih kabur (EDAFSM) dibangunkan yakni pengumpul mudah alih diubah lokasinya mengikut kesesuaian ke lokasi yang optimum di antara peristiwa-peristiwa menggunakan logik kabur. Akhirnya, satu skim logik kabur untuk pengoptimuman laluan dicadangkan untuk kecekapan tenaga lebih baik bagi EEDARS dan EDAFSM. Algoritma yang dicadangkan di atas dikenali sebagai dwi-pengumpul bersama dan penghalaan geografi berasaskan logik kabur dalam peristiwa tunggal (JDFGR-S) dan pelbagai acara (JDFGR-M). Algoritma-algoritma tersebut dibandingkan dengan tujuh teknik yang terkini. Simulasi menyeluruh dengan keadaan berbeza yang dilakukan menerusi NS2 menunjukkan peningkatan ketara dalam metrik rangkaian terutamanya hayat rangkaian, tenaga tersisa, bilangan nod yang masih hidup, nisbah penghantaran dan pengagihan beban tanpa kesan negatif dari aspek kelewatan di antara dua nod. Hayat JDFGR-S adalah 10% lebih tinggi daripada EEDARS dan hayat JDFGR-M adalah 22% lebih tinggi daripada EDAFSM. Pengesahan keputusan simulasi menunjukkan 96.53% dan kebolehpercayaan 98.98% untuk masa hidup dan metrik penggunaan tenaga. Kesimpulannya, algoritma yang telah dibangunkan meningkatkan kecekapan tenaga di WSNs berasaskan dorongan acara.